(1) Ebenezer Storer Junr.

(A)

DESCRIPTION

OF THE

AIR-PUMP,

Made in Form of a TABLE;

WITH THE

MANNER of making the moſt curious Experiments thereon.

THE

FIGURES OF THE GLASSES,

And of all the Apparatus belonging thereto, being curiouſly repreſented on a Copper-plate.

LONDON:
Sold by the MAKER, *THOMAS RIBRIGHT*,
Optician to His Royal Highneſs *GEORGE*
Prince of *Wales*, in the *Poultry*.

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Deſcription of the Apparatus *belonging to the* Air-Pump.

1. A Large Receiver for Experiments on Animals.

2. A High Receiver for the Experiment of the Guinea and Feather *in Vacuo.*

3. A Receiver, whoſe Neck is fixed to a large Tube hermetically ſealed, within which is incloſed another Tube, which is immerſed in a Glaſs Phial, to ſhew the Aſcenſion of the Quickſilver by the Preſſure of the Air.

4. A Receiver to ſhew, in very ſenſible Degree, the Weight of the Air.

5. Two Receivers, open at Top, fit for many Experiments..

6. A Braſs Plate to cover their Orifices.

7. An Inſtrument to ſuſpend, or drop any Thing within a Receiver *in vacuo*, without admitting any Air.

8. Several Kinds of Glaſſes for Experiments.

9. A Cylindrical Glaſs to hold Water, which, if made Luke-warm, will boil *in vacuo.*

10. Phials and Bladders well blown, to be burſt by the Force of the incloſed Air.

11. Square Phials to be broke by the Impreſſion of the outward Air.

12. The Spring or Expanſion of the Air, ſhewn by a ſmall Quantity of Air being left in the Folds of the Bladder, which, when the outward Air is extracted, will ſwell the Bladder to its utmoſt Extent.

13. A Bell fixed on a Pedeſtal to ſhew that no Sound can be communicated without Air.

A
GENERAL DESCRIPTION
OF THE
AIR-PUMP.

THE Pump (repreſented in the Plate) is compoſed of two Barrels, or Cylinders, *aaaa* of eight Inches Height, and an Inch and a half Diameter. The Suckers or *Piſtons* are raiſed and lowered by Means of the Handle *bb*, which is put on a Spindle that paſſes through a tooth'd Wheel, which works in the Teeth of the Piſtons *cccc*, and thereby raiſes and lowers them alternately. By which Means the ſmall Valves made of ſupple Bladder, and fixed to each Sucker, and to the Bottom of each Cylinder, alternately draw out and diſcharge the Air from the Receiver on the Top Plate of the Pump. And when the Receiver is well emptied of the Air contained in it. The Weight of the outward Air on the deſcending Sucker is nearly ſo great as to render the Force requiſite for raiſing the other, little more than what is occaſioned by the Friction of the Parts, which renders this Pump preferable to any other, being ſo convenient and portable.

The Nuts repreſented by *ddd* bind the Top on, to the Columns, and alſo on the Barrels to keep them tight in their proper Places. The Columns are *eeeee*. At the lower Part of the Cylinders or Barrels there is a Communication with a Braſs Pipe *fff*, which aſcends to the Top of the Pump at *g*. The Glaſs Receiver *hh* is placed on the Plate to be emptied— *ii* repreſents a Braſs Wire with a Hook within the Receiver, whereby you may raiſe any Thing *in vacuo*, (without admitting the Air) to what Height you pleaſe, for making Experiments.

They always put a wet Leather on the Plate, to ſet the Receivers on—— This wet Leather prevents the Air from entering the Glaſſes (whoſe Rims are ground properly) and is for that Purpoſe preferable to any Cement whatever. And not only keeps out the Air, but alſo will admit of making many Experiments at one Time, (whereas otherwiſe you could make but one) and that without Difficulty or any Dawbing.

Another Excellence in this Pump, is the Invention of the Gage *kk*, which is a ſmall Receiver made for that Purpoſe. Within it is a Glaſs Tube about 8 Inches long, hermetically ſealed at Top, and the lower End (open) reverſed into a Cup of Quickſilver. From this Gage another Braſs Tube marked *llll* proceeds, and communicates with the former, or the Tube for drawing out the Air, at *fff*. —— By this Gage, not to mention other Experiments, you may at all Times know the Degree of Rarefaction by the Fall of the Quickſilver to the tenth Part of an Inch.

Under the large Plate, is the Cock or Screw, which may be opened to let in the Air at Pleaſure into the empty Veſſels. But you muſt always take Care that the Cock is well ſtopped when you draw out the Air.

Thus far I have explained all that belongs to this light portable Machine, with the Additions that have been made. And flatter myſelf that it will be very agreeable to curious Gentlemen, who are capable of judging of its Convenience, and how far it is preferable to whatever elſe of this Kind has been hitherto publiſhed. And, in order to render it the more uſeful, I now proceed to ſhew the moſt curious Experiments that depend on the Weight, and the Spring of the Air, &c.

EXPERIMENTS ON THE AIR-PUMP,

To ſhew the EXPANSION of the Air by its Spring or Elaſticity.

1. TAKE a Bladder, ſqueeze out the Air, ſo as to leave only what remains in the Folds of the Bladder; then tie it cloſe, and ſeal it, ſo that the Air cannot eſcape. Lay it on the Air-Pump, and ſet a Receiver over it; then exhauſt the Receiver, and the Air in the Bladder will expand itſelf, ſo as to blow up the Bladder. When you let in the Air, the Bladder will return to its former Shape; which ſhews the Expanſion of the Air by its Spring or Elaſticity. *Fig.* 1.

2. To know how much the Air expands itſelf, Take a Glaſs-Bubble of about an Inch Diameter, with a Stem of about ſix or eight Inches; fill it almoſt full of Water, except a very ſmall Bubble of Air; then inverting this Bubble or Bolt Head into a Jar of Water, cover the whole with a Receiver, which exhauſt, and the little

Bubble of Air will expand itſelf: So that by comparing the Bigneſs of the ſaid Bubble of Air, as it was at firſt, to its Bigneſs when expanded, you will know the Proportion of the Expanſion of the Air. *Fig.* 2.

3. Take an Egg, and break off evenly about a third Part of the Shell at the little End, and put the Yolk and White out of the Shell, and at the Bottom you'll ſee a ſmall Bubble of Air, which lies between the Skin and the Shell; ſet the Egg (up in ſome little open Glaſs) on the Air-Pump, and put a ſmall Receiver over it, and when you exhauſt the Receiver, the Air in the Shell will expand itſelf, and raiſe up the Skin, ſo as to fill the Shell, and appear like a whole Egg. Or, take an Egg, and make a ſmall Hole in the little End, and invert it in a ſmall Glaſs. Set it on the Plate, and ſet a Receiver over it; and when you exhauſt the Receiver, the Air in the Bubble will expand itſelf, ſo as to force all the Egg out of the Shell thro' the Hole in the lower End: Then let in the Air; and if the Shell be kept down, it will all return again into the Shell, which likewiſe ſhews the Expanſion of the Air by its Spring. *Fig.* 3.

4. Take the Flint-Glaſs Bottle with the Braſs Head, and put a little Mercury in the Bottom; then take the Tube which is made for that Purpoſe, and ſcrew it into the Hole, ſo that the End may almoſt touch the Bottom of the Bottle; then ſetting the Receiver with a large Tube to cover the ſmall one over the Bottle and Tube; as you exhauſt it, you'll ſee the Mercury riſe in the Tube, according to the Expanſion of the Air in the Bottle; which (when the Receiver is quite exhauſted,

exhauſted) will ſtand at the Height of the Mercury in the common Barometer.

N. B. If you compare the Height of the Mercury in the Gage under the Pump, with the Height of the Mercury in the Tube of the Bottle aforeſaid, they will appear to be of the ſame Height; which ſhews that the Spring of the Air is juſt equal to the Preſſure of the Atmoſphere. *Fig.* 4.

5. Take Glaſs-Bubbles and hollow Glaſs Images, ſo far fill'd with Water, as to make them ſink in a Jar of Water, the Whole being ſet under a Receiver; and upon drawing out the Air, the Bubbles and Images will riſe up to the Top, but ſink down again as you let in the Air. *Fig.* 5.

6. The ſame Experiment may be made by a Bladder fill'd with Air, and juſt ſunk with Weights.

7. Take a Bladder, and ſqueeze out ſome of the Air, ſo as it will go into a wooden cylindric Box; then lay a Plate of Braſs over the Bladder, and ſcrew a Wire into the Middle of the Plate, about nine Inches high; lay on that Plate Lead Weights of what Weight you pleaſe, with Holes in the Middle to receive the Wire: Put it on the Pump with a large Receiver over it; then the Receiver being open at the Top, lay on a wet Leather, and a Plate of Braſs with a Piece of hollow Wire in the Middle, to receive the Wire in the other Plate, and to go alſo into the Holes of the Weights: Then exhauſt the Receiver, and the Air in the Bladder will expand itſelf, and raiſe up the Weights, tho' you have

above forty Pounds: Then let in the Air, and the Weights will come down as before. *Fig.* 6.

8. Take a ſmall Tube about five Inches long, and cement it into the Braſs Screw, which will fix it to the Bottle which you uſe for raiſing the Mercury; then tie a ſmall Bladder upon the End of the Tube which goes into the Bottle, and ſeal it tight, ſo that the Air cannot eſcape any where but thro' the Tube: Squeeze the Bladder together; and having put it thro' the Screw-Hole into the Bottle, ſcrew the braſs Screw with a Leather upon it, tight into the Bottle, having firſt blown up the Bladder, within the Bottle before you fix the Screw; ſo make it tight with a Key, and ſet the Machine on the Pump, with a Receiver over it. When you begin to exhauſt, the Air in the Bottle will expand itſelf, and preſs the Bladder together; which ſhews how the Lungs of an Animal *in Vacuo* are preſs'd together by the Expanſion of the Air in the *Thorax*; becauſe the Lungs having a Correſpondence with the Receiver through the Wind Pipe, have no Air in them in ſuch a Caſe, to keep up the Lungs againſt the Expanſion of the Air in the Cavity of the *Thorax*, which preſſes againſt the Outſide of the Lungs; as the Air in the Bottle in this Experiment cauſes the contained Bladder to ſubſide *in Vacuo*. *Fig.* 7.

9. Cats, or other Animals die *in Vacuo*, if the Air is not let in again very ſoon.

10. Fiſhes put in a Jar of Water under a Receiver, will (when the Receiver is exhauſted) riſe up to the Top of the Water, without being able to go down to the Bottom; becauſe the Air in their Wind Bladder being expanded againſt

their Will, makes them ſpecifically lighter than Water. Sometimes the Bladder breaks; then they will ſink down to the Bottom, and riſe no more. *N. B.* Fiſhes, Frogs, and other Animals that live in Water, will not die by exhauſting the Air from the Receiver.

11. Take a ſquare Vial, and put in a Cork; then ſeal it ſo that no Air can eſcape; and put it into a Cage of Wire; then ſet it on the Pump with a Receiver over it; and when you begin to exhauſt, the Air within the Bottle will expand itſelf ſo as to break it. When you have made this Experiment, wipe your Leather and the Pump-Plate, ſo that none of the Glaſs remain; for it may ſpoil another Experiment. *Fig.* 8.

12. The ſame Experiment is to be made with the Bottle and Cage under Water; in which Caſe the Shock will be ſo great as to ſhake the whole Pump. *Fig.* 9.

Experiments to ſhew the Spring of the Air in the Pores of Bodies.

13. TAKE an Apple, as much ſhrivel'd as can be had, and lay it on the Pump; ſet a Receiver over it: As you exhauſt the Receiver, the Apple will appear as ſmooth as one freſh gather'd. Let in the Air, and it will return to its former Shape.

14. Take a ſmall Jar or Cup, and fill it almoſt full of ſmall Beer; then taſte it, and ſet it on the Pump, and put a Receiver over it; and when you exhauſt the Receiver, the Air in Beer

will expand itſelf, and cauſe the Beer to riſe up in a Froth, ſo as to come quite over the Glaſs. Then let in the Air, and taſte the Beer, and you will find it quite dead.

15. Take a ſmall Jar or Cup, and fill it with lukewarm Water, and ſet it on the Pump, with a Receiver over it; and when you exhauſt the Receiver, the Air in the Water will expand itſelf, and raiſe large Bubbles, ſo that the Water which was lukewarm, will ſeem to boil, and diffuſe its Heat, ſo as to warm the Receiver all over: Then let in the Air, and it will immediately ceaſe to bubble.

16. Take a Piece of Cork, and fix it to a Piece of Lead, ſo as to poiſe the Cork, that it will but juſt ſink in Water; then take a Glaſs-Jar full of Water, and put in the Cork and Lead, which ſet on the Pump with a Receiver over it; and when you begin to exhauſt, the Air in the Pores of the Cork will expand itſelf, ſo as to ſwell the Cork; which therefore becoming lighter than an equal Bulk of Water, will riſe up to the Surface: Then let in the Air, and the Cork will ſink to the Bottom again. *Fig.* 10.

17. Take boil'd Water; and after having drawn as much Air out of it as can be done by the Pump, put a Piece of raw Fleſh into the Water, and you will find that upon pumping out the Air, that Air which was contained in the Fleſh, will extricate itſelf in Time, bubbling up through the Water.

N. B. There is Air in Blood, and all animal Fluids.

Experiments to ſhew the Preſſure of the Air.

18. TAKE a Glaſs open at both Ends, of about two Inches Diameter, and of what Height you pleaſe; ſet it on the Pump; then lay on your Hand, ſo as to cover the Glaſs; then begin to exhauſt, and you will feel the Preſſure of the Air; For the Air being taken from under your Hand out of the Glaſs, the external Air will preſs your Hand to the Glaſs; ſo that you can ſcarce move it: Upon letting in the Air, it will be looſen'd again.

N. B. The Spring of the Air in your Fleſh is alſo ſhewn by this Experiment; the Fleſh of the Inſide of your Hand ſwelling downward within the exhauſted Glaſs.

19. Take a Glaſs which is open at both Ends; then take a Bladder, and wet it well; ſtretch it over the largeſt End of the Glaſs, which muſt be at leaſt four Inches wide; then tie it and let it dry on; and when it is dry, ſet it on the Air-Pump, with the Bladder uppermoſt; then exhauſt the Glaſs and the external Air will break the Bladder with a large Report. *Fig.* 11.

20. Take a Piece of common Window-Glaſs, and lay it upon the Mouth of a Receiver or braſs Ferril, and ſet it on the Air-Pump, and exhauſt the Receiver or braſs Ferril, and the external Air will break the Glaſs all to Pieces, in the ſame Manner as the Bladder in the other Experiment.

21. Take a Square Bottle, and cement on a Cap of Braſs, with a Place for a Valve; then tie a ſmall Piece of wet Bladder over the Hole, ſo that the Air can come out, but cannot return the ſame Way; then put it in the Cage of Wire, and ſet it on the Air-Pump with a Receiver over it; and when you exhauſt the Receiver, the Air in the Bottle will come out thro' the Valve: When you have quite exhauſted the Receiver, let in the Air on the ſudden, which not being able to get into the Bottle, becauſe of the Valve, it will break the Bottle all to Pieces. *Fig.* 12.

22. Take a couple of braſs Hemiſpheres, and ſet them one upon another, with a wet Leather, (which has a Hole in the Middle,) in order to make them tight; and having ſcrew'd a Cock into one of them, fix it to the Pump by Means of a double Male Screw, always obſerving to have oil'd the Leather between the Screws: When you have exhauſted the Hemiſpheres, turn the Cock to ſhut their Communication with the Pump: Take off the Hemiſpheres, and they will ſtick ſo faſt as to require a great Force to pull them aſunder, about 140 Pounds, if their Diameter be equal to three Inches and a half, and proportionably more or leſs, according to their Diameters, the Weight required to draw them aſunder being greater or leſs, juſt as the Square of the Diameters of the Hemiſpheres is greater or leſs than the Square of three Inches and a half; in which Caſe the Weight is 140 Pounds.

23. The exhauſted Hemiſpheres will fall aſunder of themſelves *in Vacuo*, if you fix the uppermoſt

moſt to the Hook of the Slip-Wire before you exhauſt.

In the 13th Figure, you ſee the Hemiſpheres exhauſted *in Vacuo*. The wooden Diſh made uſe of for the Bladder, in the 7th Experiment, being ſet under to receive the falling Hemiſphere, leſt it ſhould damage the Glaſs.

24. Take the Plate of your Transforer, (which is a Six Inch Plate;) and having by Means of its Cock, fixed it to the Pump, ſcrew a ſpouting Tube to the upper Part of it, at the End of the Cock-ſcrew, which comes through the Plate. Put a wet Leather upon the Plate; then ſet upon it the talleſt Receiver you have; exhauſt it, and having turn'd the Cock, take it off of the Pump. Hold this exhauſted Machine over a Baſon of Water; and having put the Mouth of the Cock under the Water, open the Cock, and the Atmoſphere will by its Preſſure, force the Water up into the evacuated Receiver, making a pleaſant Fountain. *Fig.* 14.

25. Having exhauſted the tall Receiver abovementioned, and taken it from the Pump, take a pretty large Glaſs Fountain, or a Braſs one, with its force Pipe ſcrew'd into it, but without its Adjutage [or Spouting-pipe:] Let this Fountain be half full of Water (no Air being condens'd over the Water,) and having ſcrew'd the Cock of the Plate to it, turn the Cock, and the Air in the Fountain will by its Spring preſs ſo hard upon the Water under it, as to cauſe it to riſe through the Force Pipe quite into the exhauſted Receiver, ſpouting

up in a pleaſant Manner as before. *Fig.* 15.

26. Take a pretty tall open Receiver; and having ſet a Gallypot half full of Mercury upon the Plate of the Pump, take the four Inch Plate, and ſcrew it to the Glaſs Tube that has a double Male Screw faſtened to the End of it, ſo that when the Plate (with a wet Leather under it) is ſet upon the Receiver, the End of the Glaſs Tube may dip into the Mercury in the Gallypot. Then ſcrew the little Syringe upon the upper Screw of the ſaid Tube above the Plate and Receiver. Gently lift up the Piſton of the ſaid Syringe, and you will ſee the Mercury riſe out of the Gallypot into the Glaſs Tube: Afterwards exhauſt the Receiver as much as you can; and when no Air is left in it, you may then pull the Piſton off the Syringe quite up, without any Mercury going up the Glaſs Tube. This ſhews, that all the Phænomena of Suction and Pumps are not owing to an Abhorrence of a *Vacuum* in Nature, but to the Preſſure of the Air. *Fig.* 16.

27. Take a Lamp Cupping-Glaſs, and ſet it on the Pump with a Receiver (that hath a ſmall Hole in the Top) over it; then exhauſt the Receiver, and the Air in the Cupping Glaſs will expand itſelf and come out; then let in the Air on a ſudden, by taking off your Finger, which was held on the Hole at the Top of the Receiver, and the Cupping-Glaſs will be faſt, and the Receiver become looſened. Put on the Receiver, and exhauſt again, and the Cupping-Glaſs will be looſe, and the Receiver faſt as at firſt: But you muſt not ſet the Cupping-Glaſs

over the Hole in the Plate; becauſe then you would exhauſt that, and not the Receiver. This Experiment ſhews, that what is commonly called Suction, is only the Preſſure of the Air, which faſtens the Cupping-Glaſs, by ſtriking againſt the Outſide of it before it can get under. *Fig.* 17.

28. Take two Glaſs Bubble Fountains (that is, Glaſs Bubbles of about two Inches Diameter, with a Tube ſo cemented in the Neck of each of them, that one End almoſt touches the Bubble on the Inſide, and the other End without the Bubble, is almoſt all ſhut up, but a ſmall Pin Hole) and invert the one into a little Jar of Water, and the other into a Jar of Mercury: Then ſetting all under a Receiver, upon exhauſting it, the Air will by its Expanſion, come out of the Fountains through the Water and Mercury. As you let in the Air again, it will force up thoſe Fluids into their reſpective Fountains; which being afterwards ſet with the right End downwards in a tall Receiver, will upon exhauſting it, make Jets of Water and of Mercury by the Spring of the Air above the Mercury or Water, in the Bubbles.

N. B. You muſt not quite exhauſt the firſt Receiver, leſt too much Mercury or Water ſhould be forced into the Fountains. *Fig.* 18.

29. Take a common Barometer Tube, and fill it with Mercury, and invert it in a little Mercury in a Cup or Jar; then ſet it on the Air-Pump, and ſet a Receiver over it, open at the Top; then lay a wet Leather on the Top of the Glaſs; and take the large Tube men-

tioned in the fourth Experiment, with a Cap and a Plate cemented on the one End, hermetically ſealed at the other; and put it over the other Tube with the Mercury, ſo as to be tight with the Receiver: Then begin to exhauſt, and the Mercury in the inner Tube will come down in the ſame Proportion as that in the Gage riſes. If your Pump be tight, you may bring it quite down, ſo as to be even with the Surface of the other Mercury.

Then let in the Air very gently; for if you let it in too faſt, you will endanger breaking the Tube, and ſpoil the Experiment.

30. Take two Pieces of Marble, Planes of Glaſs, or Plates of Braſs, well poliſh'd: Then put a little Oil between 'em to keep them from admitting the Air between them; and the loweſt Marble will ſtick ſo faſt to the uppermoſt, as to hold a conſiderable Weight: Then take a Receiver, open at both Ends; ſet it on the Air-Pump, lay a wet Leather on the Top thereof; and take the Braſs Plate, with the Collar of Leathers and ſlip Wire, and ſcrew on a Hook: Put the Plate upon the Top of the Glaſs, and hang on the Marbles, or Plates on the Hook within the Glaſs; then exhauſt the Receiver, and they will drop aſunder. Then let down the upper Piece juſt upon the under, and let in the Air on a ſudden; and then the Marbles, when taken out of the Glaſs, will bear more Weight than before, when you had put them together with your Hands.

The ſame Receiver, Plate and Wire will ſerve as is uſed in the 22d Experiment. *Fig.* 13.

31. Take a ſmall Syringe, with a Lead-Weight at the Bottom; then take a tall Glaſs, and ſet it on the Air-Pump, and lay a wet Leather on the Mouth thereof; then take the three Inch Plate, with the Collar of Leathers and Wire, and ſcrew the End of the Wire into the Top of the Syringe, which put within the Glaſs, with the Lead Weight at the Bottom; then exhauſt the Glaſs, and the Weight will come down with the Barrel of the Syringe; becauſe the Air being taken out of the Receiver which preſs'd upon the Piſton of the Syringe, the Weight becomes too heavy for the Friction of the Piſton's Leather againſt the Side of the Syringe; and not being reſiſted by the Air, it muſt by Conſequence come down; let in the Air, and the Weight riſing again, will return to its former State. *Fig.* 20.

Miſcellaneous Experiments.

32. TAKE a middle ſiz'd Glaſs, wipe it well, and ſet it on the Plate; then begin to exhauſt a little, and hold a Candle on the other Side, and you will ſee a *Halo* about the Candle, or ſeveral Colours in the Glaſs, which will be ſeen only when the Glaſs is firſt exhauſting; for when the Glaſs is quite exhauſted, the Colours are loſt; but if you let in the Air, and begin to exhauſt, you will ſee the Colours as before, which may be repeated as often as you pleaſe. *Fig.* 21.

33. Take a tall Glaſs, ſet it on the Air-Pump, and lay a wet Leather on the Mouth

thereof; then take a three Inch Plate, with the Collar of Leathers and Wire, and ſcrew on the Braſs Springs with the Flap at Bottom, and a Slip-Plate to open the Spring when *in vacuo*: Screw the Slip-Plate to the Wire; then put a Piece of Gold, or what Metal you pleaſe, with a Feather or Bit of Paper, upon the Flap of the Springs under the Slip-Plate, and exhauſt the Receiver quite. Then looking into the Receiver at Bottom, pull the Wire to open the Springs, and let Fall the Gold and Feather, which will juſt come at the ſame time to the Bottom; becauſe the Air being taken away, which made the Reſiſtance, all Bodies fall equally faſt. *Fig.* 22.

34. Set your Bell upon the Plate of the Pump, and cover it with a middle-ſiz'd Receiver, then ſhake the Pump, and take notice of the Sound of the Bell: Exhauſt the Air, and you will not hear the Sound *in vacuo*, though the Clapper is made to ſtrike againſt the Side of the Bell.

35. Set a lighted Candle in your talleſt Receiver, and a few Exſuctions will cauſe the Candle to go out. The Smoke of the Candle will then be at the Top of the Receiver; but when you have pump'd out all the Air, it will then fall down. This ſhews that the Smoke does not riſe, becauſe it is poſitively light; but only becauſe it was ſpecifically lighter (or leſs heavy) than Air.

36. A Piece of lighted Charcoal, fixt by a Wire to the Braſs Hook belonging to the Collar of Leathers, ſo as to ſuſpend it in the Receiver, will go out *in vacuo*.

37. When you would fire Gunpowder *in vacuo*, take a Gallypot, and inverting it, ſet the Gunpowder Iron (that you have with the Pump) upon the Pot, having firſt made it red hot. Cover it with your Gunpowder Receiver (which muſt be firſt warm'd by Degrees leſt the Heat of the Iron ſhould crack it) and having exhauſted it, by moving the Slip Wire up and down, you will let fall a ſmall Quantity of Gunpowder upon the hot Iron, where it will fire, Corn by Corn. When you let in the Air again, let it be by little and little, leſt you Crack the Receiver.

N. B. After every Exploſion, exhauſt the Receiver, becauſe the Gunpowder generates Air, and might at laſt burſt the Receiver. *Fig.* 23.

38. If you would preſerve Fruit, Flowers, or any Thing elſe, *in vacuo*, fix the Plate of your Transferer by its Hook to the Pump-plate on which you may lay your Fruit in a Jar: Cover the whole with a Receiver, that ſtands on the Transferer with a wet Leather under it. After Exhauſtion, take off the Receiver, as is mentioned in the 24th Experiment, and keep it as long as you will, having ſcrew'd the Cock to its Wooden Foot. If you would prevent the leaſt Air from coming in, put the whole Machine under Water, and keep it ſo. *Fig.* 24.

39. Soap'd Water will riſe into large Bubbles *in vacuo*; upon which you will ſee ſeveral Colours ſucceed each other; and the Skin of Water when extreamly thin, will be black.

40. With a Piece of ſolid *Phoſphorus* write upon a Paper; and laying it upon the Plate of the Pump with another Paper under (leſt you

wet the firſt Paper) draw out the Air, and the *Phoſphorus* will brighten by Degrees, and at laſt throw up a lucid Cloud to the Top of the Receiver.

N. B. The Room muſt be dark for ſuch Kind of Experiments.

41. If you wet the Paper by Patches on which you have drawn Lines with *Phoſphorus*, inſtead of a Cloud it will give Flaſhes *in Vacuo.*

42. Take the Receiver uſed for the *Guinea and Feather-Experiment*, and to the braſs Plate, uſed to cover it, ſcrew a large Cupping-Glaſs, with a Tube cemented to its Neck, with a fine Hole in it ſo as to make a Funnel,) and having ſtopt the Hole of the Neck of the ſaid Cupping-Glaſs, with a wooden Plug, fill it with Mercury. Under the Receiver have another tall one of an arched Figure, without a Knob at Top, as in *Fig.* 5.

Then having drawn out the Air, from both Glaſſes, take out the wooden Plug, and the Weight of the external Air will force the Mercury in a Shower upon the inward Glaſs, ſo as to produce a great Light in a dark Room, if the Mercury be fine, and the Weather very dry; otherwiſe the Experiment will not ſucceed.

43. Having cemented an open Tube, ending in a Point, to a braſs Stop-Cock, put it through the braſs Plate that covers an open Receiver, ſo that the Tube ſhall reach down half an Inch below the Surface of about a Pound or two of Mercury in a Glaſs Jar under the Receiver. Shut the Cock; then exhauſt the Receiver, and then open the Cock; the Air will ruſh in through the Mercury, ſo as to throw it in little

Balls all over the Glaſs and produce a fiery Shower, viſible in a dark Room, if the Weather be dry. *Fig.* 26.

44. Having exhauſted a Receiver, let in the Air again at the Top, through an Iron Tube (or braſs Tube, whoſe End is ſcrew'd to an iron one) ſo that it may paſs through the Flame of Charcoal, before it goes into the Receiver; and when the Receiver is full of that Air, lift up the Cover of the Receiver; and letting down an Animal into the Glaſs, you will find that this infected Air will kill him immediately.

If the End of the Tube be thruſt into the Hole of a ſolid Piece of red-hot Braſs, which is not perforated quite through, the Air which muſt come into the Tube, will in its Way, carry along with it the *Effluvia* of the Braſs, which will poiſon the Air; but not ſo much as before, an Animal being longer dying in this, than in the leaſt Medium.

If a Candle be let down into the Receiver, when fill'd with Air, it will go out; but purge the Air as far as it goes: For you may let it down the ſecond Time lower than the firſt, and ſo on till the whole Air be purified.

N. B. Air burn'd in going through red-hot Iron or Copper, is not pernicious to a very tender Bird or any Animal that it has been tried upon. See *Fig.* 27.

45. To an equal (but ſmall) Quantity of Oil of Vitriol, Oil of Tartar *per deliquium*, and Oil of Cloves, put two or three ſmall Pieces of *Phoſphorus*; and this Mixture will take Fire in the open Air; but the Addition of a little common Water will put it out.

This Preparation will not only ſhine but boil up into a Flame in the exhauſted Receiver.

46. If you would weigh any Quantity of Air, take a pretty large copper or glaſs Ball, ſuch as Fountains (by Compreſſion of Air upon Water) are made of, and having by Means of a Cock fixed it to the Female Screw in the Plate of your Air-Pump, exhauſt it: Shut the Cock, and having taken off this exhauſted Ball, hang it at one End of the Beam of a Pair of Scales; counterpoiſe it at the other End; then let in the Air by opening the Cock, and the Ball will preponderate: So much Weight being required to reſtore the *Equilibrium*, as anſwers to the Weight of the Air contained in the Ball abovemention'd. *Fig*. 28.

47. To the Slip-Wire of the Collar of Leathers, at the Top of the Receiver, fix a Piece of Cork, with ſeveral ſmall Tubes going through it; and having ſet a Jar with colour'd Water in it, under the Receiver, pump out the Air; then by puſhing down the Slip-Wire, plunge the Ends of the ſmall Tubes into the colour'd Water, and it will riſe as high in thoſe Tubes as it does in open Air. See *Fig*. 2.

48. Take a Veſſel of Braſs like a Funnel or truncated Cone, open at both Ends, made ſo that the Hole at one End is not above an Inch and half Diameter, and the other End almoſt four Inches. Set this truncated Cone upon the Receiver with the ſmall Hole upwards; and having laid a Piece of flat Window Glaſs upon it, exhauſt the Air, and the Glaſs will not break. Let in the Air again, and laying the ſame Piece of Glaſs upon the larger Orifice of the braſs Veſſel,

ſel, as ſoon as you have drawn out the Air, it will break, which ſhews the Preſſure of Air is proportional to the Surface on which it preſſes.

The braſs truncated Cone is ſhewn by *Fig.* 29.

49. Flies will not die; but will be unable to fly in *Vacuo*.

50. Take a Piece of Wood with a little Hollow in it like a round Trencher, and weigh it; then having laid ſome Mercury in the ſaid Hollow, cover it with a Receiver, and when you have drawn out, and again let in the Air, you will find the Wood much heavier than it was, the Air having preſs'd a great deal of the Mercury into the Pores of the Wood. *Fig.* 30.

FINIS.